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AGRICULTURAL EXPERIMENT STATION
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DIVISION OF PLANT PATHOLOGY
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AGRICULTURAL ENGINEERING

# The Dusting of Wheat for Bunt or Stinking Smut

BY

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**In co-operation with Chelan County.

# THE DUSTING OF WHEAT FOR BUNT OR STINKING SMUT

By F. D. Heald and L. J. Smith

## INTRODUCTION

In the control of wheat smut we have passed through two periods: first the **bluestone or copper sulphate period** from the earliest times up to 1897, when formaldehyde was first employed; and second, the **formaldehyde period** from 1897 to the present time. Although the formaldehyde disinfection has very largely replaced the use of bluestone in the eastern United States, the latter has continued to be used quite extensively in the Pacific Northwest since it has been shown to have some effect in reducing the smut in winter wheat due to soil contamination, while formaldehyde has no residual action.[1]. Although both bluestone and formaldehyde treatments have proved effective in preventing bunt of wheat due to seed-borne spores, both have certain disadvantages and their employment is frequently followed by injurious effects upon the crops.

### Disadvantages of and Objections to the Standard Wet Treatments

It has long been recognized that the use of the various bluestone formulae[2] causes much reduction in the percent of germination of treated wheat. Even with close attention to standard recommendations, treated seed may frequently show as low as only 25 to 35 per cent viable, while reductions to 40 or 60 per cent viable are rather common. In addition to the killing effect of the bluestone, there may be a pronounced retardation of growth and a lowered vitality. Young seedlings may be twisted and crippled and the toxic effects persist or are only slowly outgrown. When first introduced formaldehyde was eagerly accepted as a substitute for bluestone since it was claimed to do away with the seed injury. It had the added recommendation of being cheaper and also more convenient, since it is a solution of gas in water and ready to use by diluting to the proper strength. With continued use formaldehyde has also been found to have injurious effects. The reduction in germination per

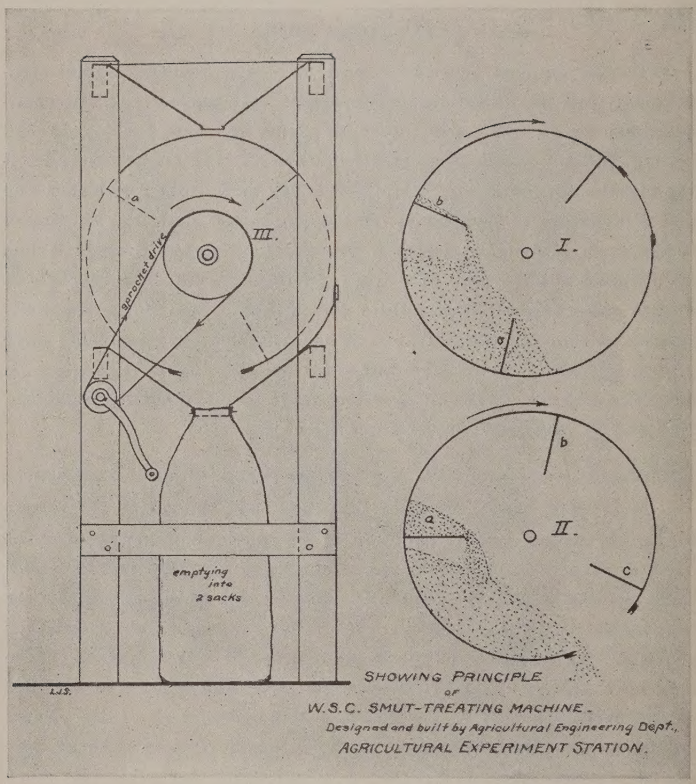


**Fig. 1.** Diagram showing the principle of the smut-treating machine. Patents applied for by the Washington Experiment Station, State College.

cent of the treated grain may be very slight, especially if the seed is planted at once in a moist soil, but injury is much more pronounced if the seed is allowed to dry before seeding or if it is seeded in dry soil[2] where it must wait for rains before germination.

It has long been known that an afterbath of bluestone-treated wheat with milk of lime greatly lessens the amount of seed injury, and it has recently been shown that the same method is effective in lessening the injury from formaldehyde[2]. The work of Braun[3] in 1920 showed that pre-soaking would accomplish the same results. While these methods reduce the seed injury and have been recommended for general use, they do not entirely eliminate the depressing effects of the bluestone treatment.

The methods of steeping grain in bluestone or in formaldehyde are inconvenient. The handling of the wet sacks of grain is a disagreeable operation, while the necessity for immersing in two successive baths is an added burden. The necessity for treating grain shortly before seeding, with special precautions concerning drying, makes both of the wet treatments objectionable. The nature of the disinfection has called for the more laborious open-tank method when the seed was heavily smutted. Grain treated by a wet method must also be protected from freezing.

**Historical Statement Concerning the Use of Copper Carbonate**

Copper carbonate as a fungicide for seed disinfection had been disregarded as its extreme insolubility in water was thought to exclude the possibility of effective action. In the form of a finely powdered dust it was first tested by Darnell-Smith[4] in New South Wales as a fungicide in the control of wheat smut. On the basis of tests conducted in 1915 and 1916 he reported in 1917 that copper carbonate dust gave better results than either formaldehyde or bluestone. A more complete report was issued in 1919, with the claim that machine-treated grain was free from smut while hand-treated grain showed a slight amount of smut. The copper carbonate dust treatment caused no injury to seed or to young plants and also resulted in very substantial increases in yield[5]. The results of Darnell-Smith were questioned by Perkins[6] in 1919 who stated that "we can not, for instance, imagine that a substance wholly insoluble in

water can have high fungicidal properties." A discussion of this criticism was published by Darnell-Smith[7] in 1921.

The excellent results obtained in Australia soon attracted the attention of American investigatiors. Mackie and Briggs[8] first reported experiments in California which corroborated the reports from Australia. They reported in 1921 that spring wheat treated with 2 ounces of copper carbonate dust per bushel was free from

Fig. 2. View of machine and wagon with sack of wheat being emptied into the drum.

smut and suffered no reduction in germination, while the untreated check gave 6.2 per cent of smutted heads.

Lambert and Bailey[9] have just recently reported perfect control of both bunt of wheat and smut of oats by using 2 ounces of copper carbonate dust per bushel. No reduction in germination of oats

resulted from using 2 ounces per bushel, while 2 to 10 ounces of the copper carbonate caused no appreciable injury to wheat.

### Comparative Seed Treatments

Since the favorable results reported by other workers have been substantiated by our own experiments, it has seemed advisable to issue this preliminary report in order that the wheat growers of our state may have our recommendations available before the time of seeding winter wheat.

In our preliminary experiments two varieties of wheat, Bluestem and Jenkins Club, were selected for test. The grain was artificially smutted, using 1 gram of smut to each 100 grams of seed. This is the amount of smut determined by previous experiments as necessary to cause fairly heavy smut but not the maximum amount. The smut was applied by shaking smut and seed together in a large jar; after which the smutted seed was divided into smaller lots, each of which received one of the treatments specified. Each lot was planted in the field in rod rows of carefully spaced seed, and greenhouse germination tests were made to determine the amount of seed injury from the respective treatments. Head and plant counts of the field plots were made at harvest time.

TABLE I.

Comparison of Dust and Wet Seed Treatments

| | BLUESTEM | | | JENKINS CLUB | | |
|---|---|---|---|---|---|---|
| Treatment | Per cent germination | Per cent smutted plants | Per cent smutted heads | Per cent germination | Per cent smutted plants | Per cent smutted heads |
| Check, untreated | 84.25 | 15.06 | 13.6 | 89.5 | 4.5 | 3.2 |
| Bluestone, wet | 67 | 0 | 0 | 65.5 | 1.2 | 0.4 |
| Formaldehyde, wet | 38.5 | 0 | 0 | 53.5 | 1.1 | 0.7 |
| Chlorophol, wet | 94.5 | 0 | 0 | 96 | 0 | 0 |
| Copper carbonate 2 oz. Dust | 91.5 | 0 | 0 | 92 | 0 | 0 |
| Copper carbonate 4 oz. Dust | 98.5 | 0 | 0 | 96.5 | 0 | 0 |
| Copper sulphate + calcium carbonate (equal parts) 2 oz. Dust | 92.5 | 0 | 0 | 94.5 | 0 | 0 |
| Sulphur, 10 lbs. " | 89. | 0.5 | 0.2 | 92. | 0 | 0 |
| Sulphur, 20 lbs. " | 94. | 0 | 0 | 93.5 | 0 | 0 |

The relatively low per cent of smut in both of the checks is explained by the high temperatures and dry conditions immediately

following planting, while the smaller amount of smut in the Jenkins Club plots was due to the proximity of these to a row of willow trees which drew very heavily on the soil moisture. It may be noted that perfect control of the smut was obtained by copper carbonate dust and also by the mixture of finely powdered anhydrous copper sulphate (bluestone) and powdered calcium carbonate. The latter mixture will result in the formation of copper carbonate as soon as the

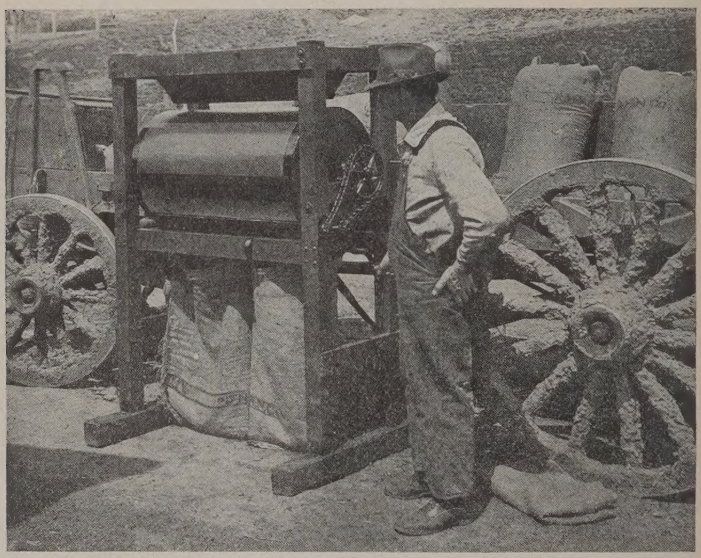

**Fig 3. View with drum of machine in position to show the opening and one of the radial mixers or buffers.**

treated grain comes in contact with soil moisture and would therefore be expected to give results similar to an initial application of copper carbonate dust. It must remain for further tests to determine the practicability of using this cheaper mixture as a substitute for copper carbonate. The dust treatments have given an improved germination of the wheat when contrasted with the bluestone and formaldehyde disinfection. The value of sulphur dust in smut control is still open to question. Even if it should continue to give the

protection as indicated by these tests, increased yields would be necessary to justify the expense of using the large amount of sulphur necessary.

Equally good results with the copper carbonate dust have been obtained at the Waterville Branch Experiment Station as reported by Mr. C. E. Hill. Untreated seed gave 86 per cent smut as contrasted with 0.5 per cent from seed treated with 2 ounces of copper carbonate per bushel. The demonstrations at a number of points in the state as reported by Mr. G. L. Zundel, Extension Plant Pathologist, have also shown the superiority of copper carbonate in smut control.

The question has been raised as to whether wheat may be dusted with copper carbonate some months previous to seeding time without suffering any injury. In order to test this point four varieties were given the standard treatment (2 ounces per bushel), and germination tests made at intervals in comparison with untreated seed. The treated and untreated seed was planted in flats in the greenhouse, using 200 seed in each lot. The appended table shows the results obtained up to the present time (Table II).

TABLE II.

**Showing Germination per cent of Untreated and Dusted Seed of Several Varieties of Wheat**

| Date of test | Jenkins Club | | Hybrid 128 | | Marquis | | Jones Winter Fife | |
|---|---|---|---|---|---|---|---|---|
| | Untreated | $CuCO_3$ | Untreated | $CuCO_3$ | Untreated | $CuCO_3$ | Untreated | $CuCO_3$ |
| Feb. 7 | 85 | 88.5 | 87.5 | 92.5 | 89.5 | 94.5 | 95 | 90.5 |
| Mar. 8 | 67.5 | 90 | 75 | 60 | 96 | 85 | 91 | 96 |
| Apr. 15 | 81.5 | * | 80 | * | 84 | * | 92 | * |
| May 8 | 76 | 95 | 79.5 | 89.5 | 77 | 96 | 84 | 96 |
| June 24 | 77 | 84.5 | 80.5 | 81.5 | 82.5 | 91.5 | 87. | 92. |

*Plants destroyed by mice.
CuCO3 is Copper Carbonate

An examination of this table will show not only that no injury resulted for the duration of the test, but that the dusted grain showed an improved germination over the untreated samples.

Mr. Hill, of the Waterville Branch Station, has reported the value of copper carbonate in lessening seed injury for late fall-seeded grain. The data in the appended table (Table III) are taken from his report.

TABLE III.

Germination per cent of Fall-Seeded Wheat

| Treatment | Per Cent of Germination | |
|---|---|---|
| | Hybrid 128 | Turkey |
| Untreated seed | 90 | 95 |
| Formaldehyde 1-30 | 36 | 45 |
| Formaldehyde 1-50 | 63 | 70 |
| Bluestone 1-5 | 40 | 52 |
| Copper carbonate 2 oz. dust | 90 | 95 |

Specific data concerning the comparative value of copper carbonate dust and the standard bluestone treatment in preventing smut from soil contamination will not be available until the end of the 1922 harvest.

Preliminary tests, however, indicate that the carbonate dust will be much more effective. Copper sulphate is very readily soluable in the soil moisture and is quite rapidly removed from the vicinity of germinating grains, while copper carbonate is very slowly soluble and should therefore have a more persistent effect.

**Formula and Methods of Application of Copper Carbonate Dust**

On the basis of completed trials our present recommendation is the use of 2 ounces of finely powdered copper carbonate, testing 50 per cent or more of metallic copper, per bushel of wheat. The powder should be fine enough to pass through at least a 100-mesh sieve. The effectiveness of the treatment depends on the uniform distribution of the finely divided particles over the surface of the grain. Two ounces per bushel gives a complete coating, and no added protection has been afforded by using 4 ounces per bushel. Work now in progress will tell whether it will be possible to use less dust per bushel and still obtain effective protection.

The application of the copper carbonate dust may be made in a number of different ways. In our earliest experimental work the treatment was carried out by shaking the seed and the requisite amount of copper carbonate in a closed container. A barrel churn has been used with good results, while in some larger operations a small concrete mixer has been tried. In some of the demonstration trials the dusting has been accomplished by emptying the wheat and the desired amount of copper carbonate on a canvas and shoveling

Fig. 4. View of machine with the two sacks partially filled. A second lot is treated before the sacks are ready to be removed.

over the mixture until the grain became thoroughly coated, but this last method is not recommended as it is felt that it gives the least effective distribution of the dust and offers more opportunity for persons doing the treating to inhale the irritating and poisonous dust particles. A special dusting machine has been designed which is effective and also convenient, and it is expected that this or a similar machine will come into general use.

### Washington State College Smut-Treating Machine*

In designing a machine for the dry or dust treatment of wheat for smut the following points were kept in mind: (1) To handle the grain as little as possible; (2) To mix the grain and copper carbonate in sack lots; (3) To make the machine self-bagging; (4) To sack the

Fig. 5. View of the small dusting machine, which is arranged to empty into a box or tray.

grain in quantities that could easily be handled at the drill; (5) To mix the grain with as few turns of the drum as would give effective distribution; (6) To avoid the disagreeable copper carbonate dust; (7) To build a machine that a farmer having mechanical ability might make.

The accompanying illustration (Fig.1) shows the principle of the mixer. The drum is revolved until the opening is under the fill-

*Patents Applied for.

ing hopper. A stop bolt through the vertical post holds the drum in filling position. The helper on the wagon then empties a sack of grain into the hopper and it flows into the drum. (Fig. 2). The drum is then turned back so the operator standing on the ground can scatter the copper carbonate uniformly over the surface of the grain, after which the sliding door is put in position and the drum rotated for two minutes. This gives 20 to 30 revolutions per minute which is sufficient to coat thoroughly each grain with the powder.

In the drum there are three wooden radial mixers or buffers, of a width equal to half the radius of the drum (Figs. 1, 3). In position I the grain has slid off the board "b" and is being lifted by "a," during which time it flows over "a" like water over a dam. It should be noticed that the upper portion of the grain is passing over "a" first. Position II shows the bottom portion of the grain leaving "a" and forming the top of the pile below. Thus the grain is largely reversed in position each time it passes over a mixing-board, making three mixes per revolution of the drum. When the two-minute mixing period is completed, the drum is stopped at its filling position, and the sliding cover is pulled out. The drum is then turned one-half a revolution to position III at which position the treated grain is equally dumped into the two sacks below and is ready to be tied up for use in the field. (Fig. 4).

The ratio of the sprockets is 1 to 4, there being 6 teeth on the drive sprocket and 24 on the drum sprocket. The drum is 21 inches in diameter and 36 inches long. The machine stands five and one-half feet in height. The machine has a capacity of one full sack of wheat, but it is expected that partial sacks (1½ bushels) will be used. In treating a sack of wheat, the crank turns by hand about as hard as a cream separator. One sack can easily be run through every four or five minutes. It would therefore not take long to treat enough seed for a large field.

A blueprint showing all the dimensions of the smut-treating machine will be sent upon application, with a covering fee of twenty-five cents.

The first machine made to test the utility of this principle of mixing is shown in Fig. 5. The drum is 16 inches in diameter and 24 inches long. It was built as an investigational study in Agricul-

tural Engineering by a student, Stephen White, whose ideas assisted very materially in the development of the larger machine. The small mixer will treat one-half bushel at a time. It is about as large as can be conveniently turned with the crank fastened to the axle of the drum, and would do very well for treating seed for small fields.

### Advantages of the Copper Carbonate Treatment

The advantages of the dust treatment are so pronounced that this method of control may be expected to replace the older wet treatments with bluestone or formaldehyde. It is our prophecy that we are now beginning the "copper carbonate dust period of seed disinfection." The important advantages of this copper carbonate dust may be briefly enumerated as follows:

1. The elimination of the inconvenient and disagreeable soaking methods.

2. The convenience of being able to treat seed days or even months before it is needed for use, thus making possible the utilization of spare time.

3. The elimination of seed injury and retarded growth, with even an improvement in germination over that of untreated seed. This will make possible a reduction in the amount of seed used per acre and should result in a considerable annual saving as soon as the method comes to be generally practiced.

4. The elimination of danger from seeding in the dry, making it possible to seed in the "dust," rather than being obliged to wait for rain.

5. Probable increased yields due to better stands, no retarding influence of the fungicide, and better control of smut.

6. A probable increased protection from reinfection of treated seed by smutty sacks, broken smut balls or from the wind-borne spores that are generally present in our summer fallow fields.

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